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(54) Title: USE OF THYMOSIN ALPHA 1 FOR THE MANUFACTURE OF A MEDICAMENT FOR PROMOTING STEM CELL DEVELOPMENT

(57) Abstract

A method of promoting stem cell development in a mammal in need of stem cell development includes administering to the mammal a stem cell development enhancing effective amount of Thymosin  $\alpha_1$  (T $\alpha_1$ ).

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USE OF THYMOSIN ALPHA 1 FOR THE MANUFACTURE OF A MEDICAMENT FOR PROMOTING STEM CELL DEVELOPMENT

Field of the Invention

The present invention relates generally to a  
5 method of promoting stem cell development.

Background of the Invention

Both B lymphocytes ("B cells") and T lymphocytes ("T cells") play important roles in mammalian immune systems. B cells control humoral immunity through  
10 antibody production. T cells account for nearly all forms of cellular immunity.

T cells originate in the thymus. Generally, thymic stem cells which are derived from precursor cells originating in bone marrow develop into blast cells which, in turn, develop into a variety of mature T cells. The developmental process from stem cell to mature T cell is referred to as stem cell differentiation or thymopoiesis. The developmental process from bone marrow precursor cell to mature T  
15 cell is referred to as T cell development. Stem cell development may include stem cell proliferation and differentiation into T cells. If stem cell differentiation progresses slowly or incompletely or if there is a shortage of stem cells in the thymus, a  
20 deficiency of T cells can result.

Thus, a T cell deficiency can result from a number of different factors. For example, T cell deficiencies exist in immunodeficient humans, such as individuals infected with HIV. In humans infected with HIV, it is 5 believed that such deficiencies result not only from the virus attacking and killing T cells (e.g., CD4 cells) but also from a decrease in stem cell differentiation in the infected humans due to a change in the thymic milieu caused by the overall HIV 10 infection. Moreover, T cell deficiencies exist in humans having a shortage of stem cells, such as individuals in need of a bone marrow transplant.

Thymosin Fraction Five (TF-5), originally described by Goldstein et al. (Proc. Nat'l Acad. Sci. (USA), 69:1800-1803 (1972)), is a partially purified extract of bovine thymus containing at least 40 peptide components, 20 of which have been purified to homogeneity or near homogeneity; it contains about 0.6% of Thymosin  $\alpha_1$  (T $\alpha_1$ ). Low, T.L.K., et al., "Thymosins: 20 Structure, Function and Therapeutic Application", Thymus, 6:27-42 (1984).

Thymosin  $\alpha_1$  ("T $\alpha_1$ ") is a peptide originally derived from the thymus gland, which has been reported as containing 28 amino acids. Amino acid sequence 25 information on T $\alpha_1$  is disclosed in U.S. Patent No. 4,079,127.

T $\alpha_1$  is an immune system modulator which heretofore has been reported as being useful, inter alia, in the treatment of lung cancer, Hepatitis B and Hepatitis C. 30 Moreover, it previously has been suggested that T $\alpha_1$  might induce the expression of certain T cell markers as well as functional activity associated with lymphocyte maturation such as helper T cell activity, specific antibody production and production of

macrophage inhibiting factor. Low, 1984, supra, at page 33.

A T cell deficiency as described above can have devastating and sometimes fatal effects on those 5 afflicted with this condition, as is evident from recent experience with AIDS. Clearly, there is a need in the art for new and effective methods of promoting development in humans who are T cell deficient. Accordingly, there is a need in the art for new and 10 effective methods of promoting stem cell development in those individuals in need of such development.

#### Summary of the Invention

In accordance with the present invention, a method of promoting stem development in a mammal in need of 15 stem cell development includes administering to said mammal a stem cell development enhancing effective amount of Thymosin  $\alpha_1$ .

Also in accordance with the present invention, a method of promoting T cell differentiation from stem 20 cells in a mammal in need of T cell differentiation includes administering to said mammal a T cell differentiation effective amount of Thymosin  $\alpha_1$ .

#### Brief Description of the Drawings

Fig. 1 is a schematic diagram depicting the *in vitro* coculture model of thymopoiesis utilized in 25 Example 3.

Fig. 2 is a graph depicting the results of purifying CD34+ stem cells from bone marrow. These results show that >99% of the stem cells utilized in

the *in vitro* coculture model of thymopoiesis expressed CD34+.

5 Fig. 3 depicts flow cytometry results which show the effect which  $T\alpha_1$  had on the cell number per well as a function of time in the *in vitro* stem cell-cultured thymic epithelial fragment (SC-CTEF) coculture model of thymopoiesis illustrated in Fig. 1.

10 Fig. 4 depicts flow cytometry results which show the effect  $T\alpha_1$  had on the expression of CD25+ as a function of time in the *in vitro* SC-CTEF coculture model of thymopoiesis illustrated in Fig. 1.

15 Fig. 5 depicts flow cytometry results which show the effect  $T\alpha_1$  had on the expression of CD44+25+ as a function of time in the *in vitro* SC-CTEF coculture model of thymopoiesis illustrated in Fig. 1.

Fig. 6 depicts flow cytometry results which show the effect  $T\alpha_1$  had on the expression of CD44+25+3- as a function of time in the *in vitro* SC-CTEF coculture model of thymopoiesis illustrated in Fig. 1.

20 Fig. 7 depicts flow cytometry results which show the effect  $T\alpha_1$  had on the expression of single positive CD4+ (spCD4+) as a function of time in the *in vitro* coculture model of thymopoiesis illustrated in Fig. 1.

25 **Description of the Preferred Embodiments**

It surprisingly has been discovered that Thymosin  $\alpha_1$  ( $T\alpha_1$ ) is particularly and unexpectedly effective in promoting stem cell development. This is particularly advantageous for mammals in need of such 30 development.

The terms "Thymosin  $\alpha_1$ " and "T $\alpha_1$ " refer to peptides having the amino acid sequence disclosed in U.S. Patent No. 4,079,127, the disclosure of which is incorporated herein by reference.

5 According to the present invention, methods of promoting stem cell development and T cell differentiation from stem cells are provided. The methods of the present invention include administering to the mammal a stem cell development enhancing 10 effective amount of T $\alpha_1$ .

According to preferred embodiments of the present invention, effective amounts of T $\alpha_1$  are administered to mammals in need of stem cell development to promote stem cell development in the mammals. The amount of T $\alpha_1$  15 administered to the mammals to promote stem cell development is preferably between about 0.1  $\mu$ g T $\alpha_1$  per kg body weight of the mammal and about 4  $\mu$ g T $\alpha_1$  per kg body weight and, more preferably, between about 5  $\mu$ g T $\alpha_1$  per kg body weight (i.e., about 0.5 mg T $\alpha_1$ ) and about 20 20  $\mu$ g T $\alpha_1$  per kg body weight (i.e., about 5 mg T $\alpha_1$ ). In a most preferred embodiment of this invention, about 20  $\mu$ g T $\alpha_1$  per kg body weight (i.e., about 1.6 mg T $\alpha_1$ ) is administered to the mammals in need of stem cell 25 development. Actual dosages administered can be in the range of about 0.1-10 mg, about 0.5 - 5 mg or about 1-2 mg, with a dosage of 1.6 mg being contemplated. In these embodiments, the mammals preferably are human.

According to one aspect of the present invention, the mammals to which T $\alpha_1$  is administered are in need of 30 stem cell development. Mammals in need of stem cell development may include, but are not limited to, mammals that are T cell- and/or stem cell-deficient.

T $\alpha_1$  may also promote stem cell proliferation. Mammals afflicted with an immunodeficiency disease (e.g., humans who have AIDS or are HIV positive) and animals in need of a bone marrow transplant are generally in 5 need of stem development. According to another aspect of the present invention, T $\alpha_1$  can be administered to mammals in need of stem cell development on a routine basis. For example, T $\alpha_1$  can be administered daily, twice a day, three times a day, every other day, 10 weekly, monthly, etc. The frequency of administration, of course, will depend upon the quantity and formulation of T $\alpha_1$  being administered.

According to the preferred embodiments of the present invention, compositions containing T $\alpha_1$  may be 15 formulated in a conventional manner for administration by any suitable route. Suitable routes of administration include, but are not limited to, oral, rectal, nasal, topical, vaginal, and parenteral (including subcutaneous, intramuscular, intravenous and 20 intradermal). Particularly preferred embodiments utilize oral or parenteral administration, with parenteral administration being a more preferred embodiment. It will be appreciated that the preferred route may vary with the condition, age and species of 25 the recipient.

While not essential, in preferred embodiments, T $\alpha_1$  is administered as part of a pharmaceutical formulation. The formulations of the present invention comprise T $\alpha_1$  together with one or more pharmaceutically 30 acceptable carriers and optionally with other therapeutic ingredients. The carrier(s) are "acceptable" in the sense of being compatible with the

other ingredients of the formulation and not deleterious to the recipient thereof.

The formulations include those suitable for oral, rectal, nasal, topical (including buccal and 5 sublingual), vaginal or parenteral (including subcutaneous, intramuscular, intravenous and intradermal) administration. The formulations may conveniently be presented in unit dosage form, e.g., tablets and sustained release capsules, and may be 10 prepared by any suitable pharmaceutical methods.

Such methods include, but are not limited to, the step of bringing into association  $T\alpha_1$  with the carrier which constitutes one or more accessory ingredients. In general, the formulations are prepared by uniformly 15 and intimately bringing into association  $T\alpha_1$  with liquid carriers or finely divided solid carriers or both, and then, if necessary, shaping the product.

Formulations of the present invention suitable for oral administration may be presented as discrete units 20 such as capsules, cachets or tablets each containing a predetermined amount of  $T\alpha_1$ ; as a powder or granules; as a solution or a suspension in an aqueous liquid or a non-aqueous liquid; or as an oil-in-water liquid emulsion or a water-in-oil liquid emulsion, etc.

A tablet may be made by compression or molding, 25 optionally with one or more accessory ingredients. Compressed tablets may be prepared by compressing in a suitable machine  $T\alpha_1$  in a free-flowing form such as a powder or granules, optionally mixed with a binder, 30 lubricant, inert diluent, preservative, surface-active or dispersing agent. Molded tablets may be made by molding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent. The tablets may optionally be coated or scored and may be

formulated so as to provide slow or controlled release of the active ingredient therein.

Formulations suitable for topical administration include lozenges comprising  $T\alpha_1$  in a flavored basis, 5 usually sucrose and acacia or tragacanth; pastilles comprising  $T\alpha_1$  in an inert basis such as gelatin and glycerin, or sucrose and acacia; and mouthwashes comprising  $T\alpha_1$  to be administered in a suitable liquid carrier.

10 Formulations suitable for topical administration to the skin may be presented as ointments, creams, gels and pastes comprising  $T\alpha_1$  and a pharmaceutically acceptable carrier, or may utilize a transdermal patch containing the ingredient to be administered.

15 Formulations for rectal administration may be presented as a suppository with a suitable base comprising, for example, cocoa butter or a salicylate.

20 Formulations suitable for nasal administration wherein the carrier is a solid include a coarse powder having a particle size, for example, in the range from about 20 to about 500 microns which is administered in the manner in which snuff is taken, i.e., by rapid inhalation through the nasal passage from a container of the powder held close up to the nose. Suitable 25 formulations wherein the carrier is a liquid, for administration, as for example, a nasal spray or as nasal drops, include aqueous or oily solutions of the active ingredient.

30 Formulations suitable for vaginal administration may be presented as tampons, creams, gels, pastes, foams or spray formulations containing, in addition to  $T\alpha_1$ , suitable carriers.

Formulations suitable for parenteral administration include aqueous and non-aqueous sterile

injection solutions which may optionally contain antioxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the intended recipient; and aqueous and non-aqueous sterile suspensions which may include suspending agents and thickening agents. The formulations may be presented in unit-dose or multi-dose containers, for example, sealed ampules and vials, and may be stored in a freeze-dried (lyophilized) condition requiring only the addition of the sterile liquid carrier, for example water for injections, immediately prior to use. Extemporaneous injection solutions and suspensions may be prepared from sterile powders, granules and tablets of the kind previously described.

It should be understood that in addition to the ingredients particularly mentioned above the formulations of this invention may include other suitable agents having regard to the type of formulation in question, for example, those suitable for oral administration may include flavoring agents.

The present invention is applicable to native (i.e., naturally occurring)  $T\alpha_1$ , as well as synthetic  $T\alpha_1$  and recombinant  $T\alpha_1$  having the amino acid sequence of native  $T\alpha_1$ , amino acid sequences substantially similar thereto, or an abbreviated sequence form thereof, and their biologically active analogs (including muteins) having substituted, deleted, elongated, replaced, or otherwise modified sequences which possess bioactivity substantially similar to that of  $T\alpha_1$ .

The following examples are for illustrative purposes only, and are not to be construed in a limiting sense.

ExamplesEXAMPLE 1Preparation of Injectable Formulation

5 Pharmaceutical dosage units of 1 ml each are prepared from the ingredients shown in Table 1 below.

TABLE 1

	<u>Active Ingredient</u>	<u>Amount Per mL</u>
	Thymosin $\alpha$ -1	0.0064 g
<u>Inactive Ingredients</u>		
10	mannitol, U.S.P.	0.050 g
	sodium phosphate dibasic, heptahydrate, U.S.P.	0.002 g
	sodium phosphate monobasic, monohydrate, U.S.P.	0.0005 g
15	sodium phosphate dibasic, 2 mg/ml solution	
	sodium phosphate monobasic, 0.5 mg/ml solution	
	water for injection, U.S.P.	

EXAMPLE 2Preparation of Injectable Formulation

Pharmaceutical dosage units of 1 ml each are prepared from the ingredients shown in Table 2 below.

5

TABLE 2

	<u>Active Ingredient</u>	<u>Amount Per mL</u>
	Thymosin $\alpha$ -1	0.0032 g
<u>Inactive Ingredients</u>		
	mannitol, U.S.P.	0.050 g
10	sodium phosphate dibasic, heptahydrate, U.S.P.	0.002 g
	sodium phosphate monobasic, monohydrate, U.S.P.	0.0005 g
15	sodium phosphate dibasic, 2 mg/ml solution	
	sodium phosphate monobasic, 0.5 mg/ml solution	
	water for injection, U.S.P.	

EXAMPLE 3Effects of Thymosin- $\alpha_1$  on CD34+ Stem Cell Differentiation in Cultured Thymic Epithelia in vitroMaterial and Methods

5 To evaluate the effect of  $\text{T}\alpha_1$  on thymopoiesis, an *in vitro* coculture model of thymopoiesis was utilized. In this model, as set forth in Figure 1, CD34+ stem cells were isolated from bone marrow by positive selection using CD34+ antibody coated beads and 10 immunomagnetic selection, MiniMACS (Miltenyi). As illustrated in Figure 2, the separation procedure was extremely efficient with >99% of the stem cells expressing CD34+. CD34+ stem cells were a heterogeneous population. Thus, in some experiments, 15 more immature CD34+ population was used, depleted of CD2+CD4+ cells.

20 Thymus tissue was obtained from children less than 2 years of age undergoing cardiac surgery. The thymic tissue was minced into 1 mm<sup>3</sup> fragments and cultured in 1.35 mM 2-deoxyguanosine for 10-14 days in order to deplete the thymic tissue of thymocytes in a 5% CO<sub>2</sub> humidified atmosphere. The thymic fragments were then cultured in growth media (Iscove's/Ham's F-12 media supplemented with 5% FCS and epidermal growth factor).

25 Subsequently, CD34+ stem cells were cocultured with the cultured thymic epithelia fragments in 24-well transwell culture plates in Iscove's/Ham's F-12 media supplemented with 5% FCS, epidermal growth factor and IL-2 in a 5% CO<sub>2</sub> humidified atmosphere. Approximately 30 100,000 CD34+ stem cells were cocultured with 3-5 thymic fragments. 10  $\mu\text{g}/\text{ml}$  of  $\text{T}\alpha_1$  was added to parallel

cocultures. Media and  $T\alpha_1$  of cocultures were replaced twice weekly.

At weekly intervals, cultures were harvested to analyze thymocyte subpopulations by flow cytometry.

5 T cell surface phenotypes of the differentiated stem cells were determined by reacting monoclonal antibodies (mAb) conjugated with either fluorescein (FITC), phycoerythrin (PR), and peridinin chlorophyll protein (Per-CP) and were then analyzed by flow cytometry.

10 Monoclonal antibodies used are listed in Table 3 below. Combinations of mAbs were used to identify immature thymocytes, such as double-positive (CD3-CD4+CD8+) and triple positive (CD3+CD4+CD8+) thymocytes, and mature CD3+CD4+CD8- and CD3+CD4+CD8+ T cells. Analysis of 15 thymocyte subpopulations was performed using WinList software.

### Results

Initially, a dose response of  $T\alpha_1$  was performed ranging from 1 to 10  $\mu$ g/ml. Optimal effects were 20 observed at 10  $\mu$ g/ml which then was used in subsequent experiments. As shown in Figure 3,  $T\alpha_1$  increased the proliferation of cocultured cells harvested at all time points from the cocultures compared to media alone. Increased proliferation or expansion of thymocytes 25 stimulated by  $T\alpha_1$  paralleled media alone with peak proliferation observed at 3 weeks, 16.6 versus 10.4 fold increase.

Thymocyte subpopulations were then analyzed to determine whether  $T\alpha_1$  affected thymocyte maturation. As 30 illustrated in Figure 4,  $T\alpha_1$  significantly increased thymocyte CD25+ expression at 1, 3 and 4 weeks of coculture.  $T\alpha_1$  significantly stimulated CD25+

expression at 1 week, 40% versus 23%, and was significantly increased at 4 weeks, 56% versus 31%.

CD44 and CD25 expression were also evaluated in this model system since CD44 expression appears early in differentiation in the subcapsular cortex prior to expression of TCR, CD3, CD4 and CD8, i.e. triple negative thymocytes. Other groups have reported that CD44 plays an important role in thymocyte migration and maturation. As thymocytes further mature through double and triple positive thymocyte stages, CD44 disappears but then reappears in more mature thymocytes. The ligands for CD44 include hyaluronate and fibronectin, matrix proteins which promote cell adhesion. In this model of stem cell differentiation,  $T\alpha_1$  significantly increased CD44+CD25+ expression in the first three weeks of coculture, peaking at 3 weeks 46% versus 30%. See Figure 5. Furthermore,  $T\alpha_1$  increased early thymocyte maturation by increased expression of CD44+25+3- thymocytes at 1 week, 12% versus 7%. See Figure 6. Though  $T\alpha_1$  did not affect CD3, CD4 CD8 expression, it did increase mature single positive CD3+4+ expression at 3 weeks, 31% versus 23%. Other thymocyte surface phenotypes, such as TCR, CD2, CD7, CD45RA and CD45RO, were not affected by  $T\alpha_1$ .

Thus,  $T\alpha_1$  dramatically increased CD25 expression throughout the coculture period. It stimulated expression of an early thymocyte, CD44+25+3- pre-T cell, at 1 week of coculture. As thymocytes matured, expression of this thymocyte stage waned similar to control cocultures.  $T\alpha_1$  also promoted expression of mature single positive CD4+ T cells at 3 weeks of coculture. Throughout the coculture period,  $T\alpha_1$  stimulated proliferation of thymocytes. From these

studies it is clear that  $T\alpha_1$  promotes T cell differentiation from stem cells.

**TABLE 3**  
**Monoclonal antibodies**

<b>mAb</b>	<b>Clone</b>	<b>Specificity</b>
<i>Mononuclear Cells</i>		
CD7	Leu9	Prethymic Precursor T cell
5	CD33	LeuM9 Progenitors, monocytes; related to myelin-associated glycoprotein
	CD34	HPCA-2 Bone marrow progenitor cell
	CD38	Leu17 Progenitors; growth-factor receptor
	CD44	Leu44 Progenitor cell committed to thymocytes and thymic dendritic cells
10	CD2	Leu5b T and NK cells; cytoadhesion molecule binding LFA-3
	CD3	Leu4 Multichain receptor associated with TCR
	CD4	Leu3a T helper/inducer; cytoadhesion glycoprotein binds to MHC II
	CD8	Leu2a T cytotoxic/suppressor; cytoadhesion glycoprotein binds to MHC I
	TCR $\alpha\beta$	WT31 T cell receptor $\alpha/\beta$ chains
15	TCR $\gamma\delta$	11F2 T cell receptor $\gamma/\delta$ chains
	CD25	2A3 Low affinity IL-2 $\alpha$ chain receptor
	CD69	Leu23 B- and T cells; activation-inducer
	CD45RA	Leu18 Isoform of CD45; naive cell
	CD45RO	UCHL-1 Isoform of CD45; memory cell
20	CD14	LeuM3 Monocytes, dendritic cells
	CD49d	HP2.1 VLA- $\alpha$ 4 integrin chain, fibronectin receptor
	CD49e	SAM1 VLA- $\alpha$ 5 integrin chain, fibronectin receptor
	CD11a	25.3 LFA-1 integrin $\alpha$ L chain
	CD18	7E4 Integrin $\beta$ 2 chain
25	CD29	K20 Integrin $\beta$ 1 chain
	CD16	Leu11c Natural killer, granulocytes; Fc $\gamma$ RIII
	CD56	Leu19 Isoform of N-CAM; NK and T cytotoxic subset
	CD20	Leu16 B cells
	HLA-DR	DR HLA cells class II molecules

mAb	Clone	Specificity	
		<i>Thymic Epithelia</i>	
TE3	7B12	Cortical thymic epithelium and fibroblast	
TE4	TE4	Medullary and subcapsular cortical thymic endocrine epithelium	
CDR2		pan epithelia	
		<i>HIV</i>	
5 p24	26C	HIV-1 p24, cytoplasmic	
Protease	H2930	HIV-1 protease	

EXAMPLE 4Treatment of Adults in Need of Stem Cell10 Differentiation With T $\alpha_1$ 

Adult patients in need of stem cell differentiation are selected (e.g., adults with a T cell count of less than 200).

15 Each patient receives T $\alpha_1$  at a dose of 1.6 mg subcutaneously (SQ) every other day.

Outpatient following is initially at one-week intervals for two weeks, then at two-week intervals for two months, and then monthly for the remainder of the treatment period. At each visit the T cell count is 20 monitored.

Drug toxicity is monitored on an ongoing basis using both clinical and laboratory parameters.

While the invention has been described and 25 illustrated with details and references to certain preferred embodiments, those skilled in the art will appreciate that various modifications, changes,

omissions, and substitutions can be made without departing from the spirit of the invention.

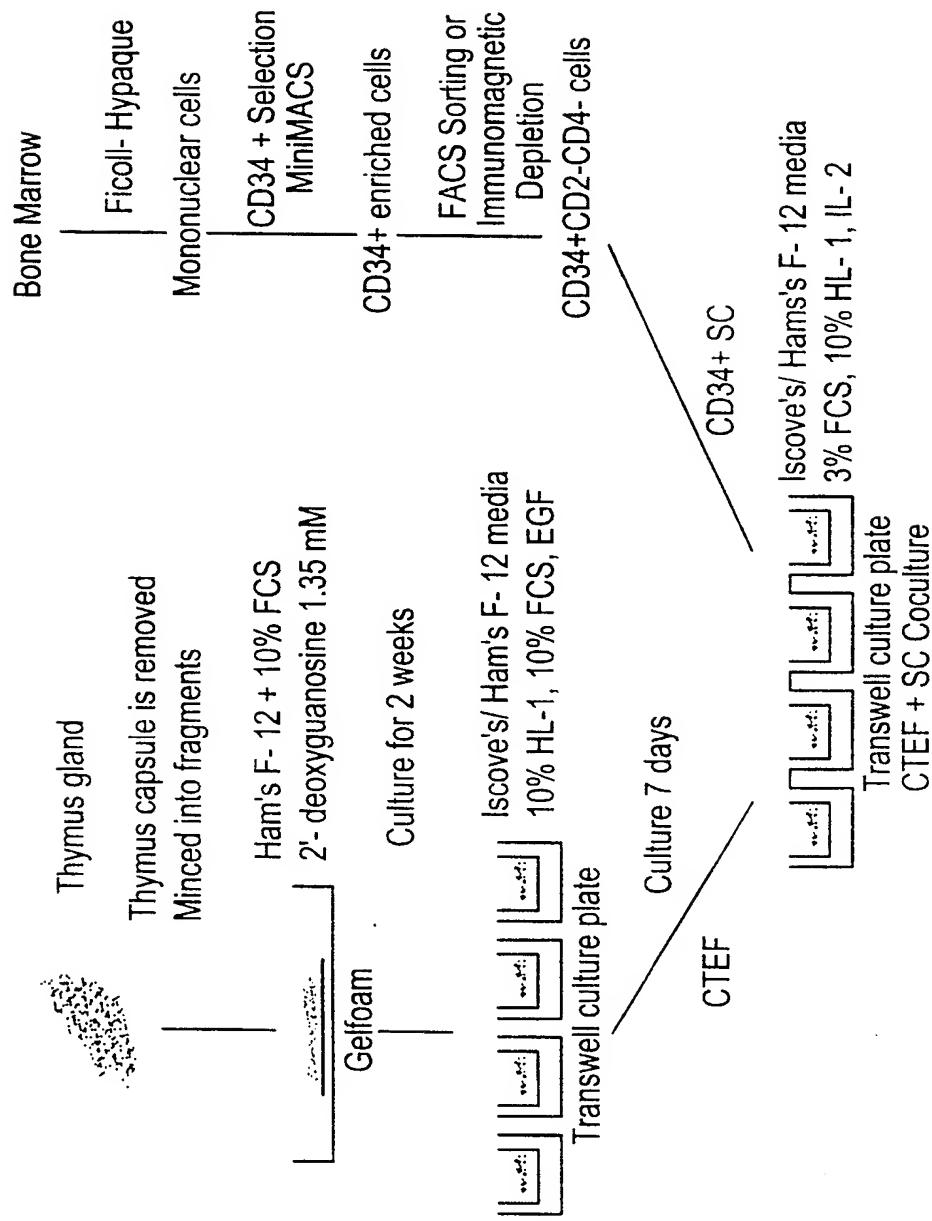
**What is claimed is:**

1. A method of promoting stem cell development in a mammal in need of stem cell development which comprises administering to said mammal a stem cell development enhancing effective amount of Thymosin  $\alpha_1$  ( $T\alpha_1$ ).  
5
2. The method of claim 1, wherein said mammal is HIV positive.
3. The method of claim 1, wherein said mammal is  
10 in need of a bone marrow transplant.
4. The method of claim 1, wherein the amount of  $T\alpha_1$  administered to said mammal is between about 0.1  $\mu\text{g}$   $T\alpha_1$  per kg body weight of the mammal and about 4.0  $\mu\text{g}$   $T\alpha_1$  per kg body weight.
- 15 5. The method of claim 4, wherein the amount of  $T\alpha_1$  administered to said mammal is between about 5  $\mu\text{g}$   $T\alpha_1$  per kg body weight of the mammal and about 65  $\mu\text{g}$   $T\alpha_1$  per kg body weight.
- 20 6. The method of claim 5, wherein the amount of  $T\alpha_1$  administered to said mammal is about 20  $\mu\text{g}$   $T\alpha_1$  per kg body weight of the mammal.
7. The method of claim 1, wherein said mammal is  
25 human.
8. The method of claim 1, comprising promoting T cell differentiation from said stem cells.
- 25 9. The method of claim 1, wherein said amount is a dosage of about 0.1-10 mg.
10. The method of claim 1, wherein said amount is a dosage of about 0.5-5 mg.
- 30 11. The method of claim 1, wherein said amount is a dosage of about 1-2 mg.

12. The method of claim 1, wherein said amount is a dosage of about 1.6 mg.

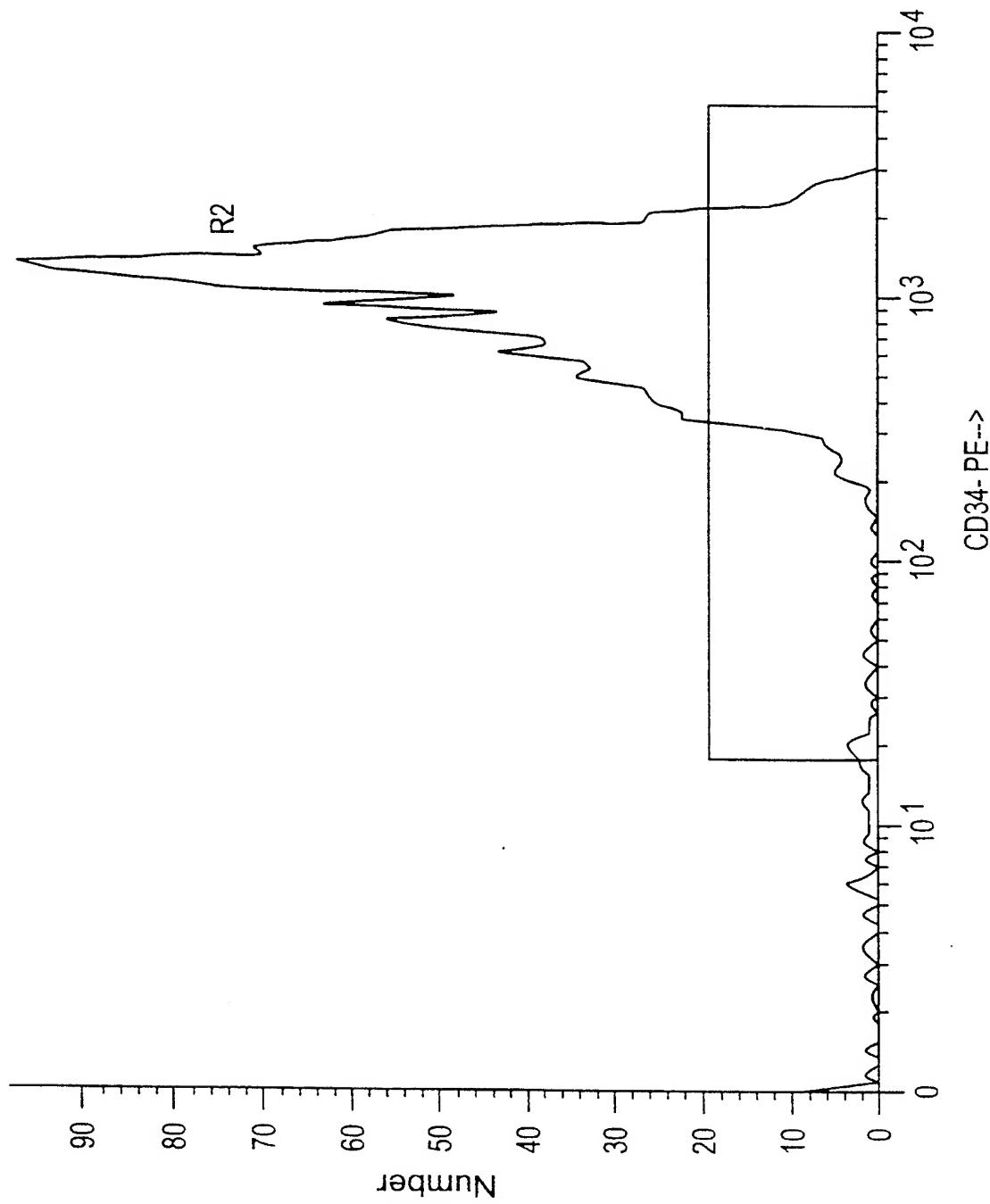
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## FIG. 1



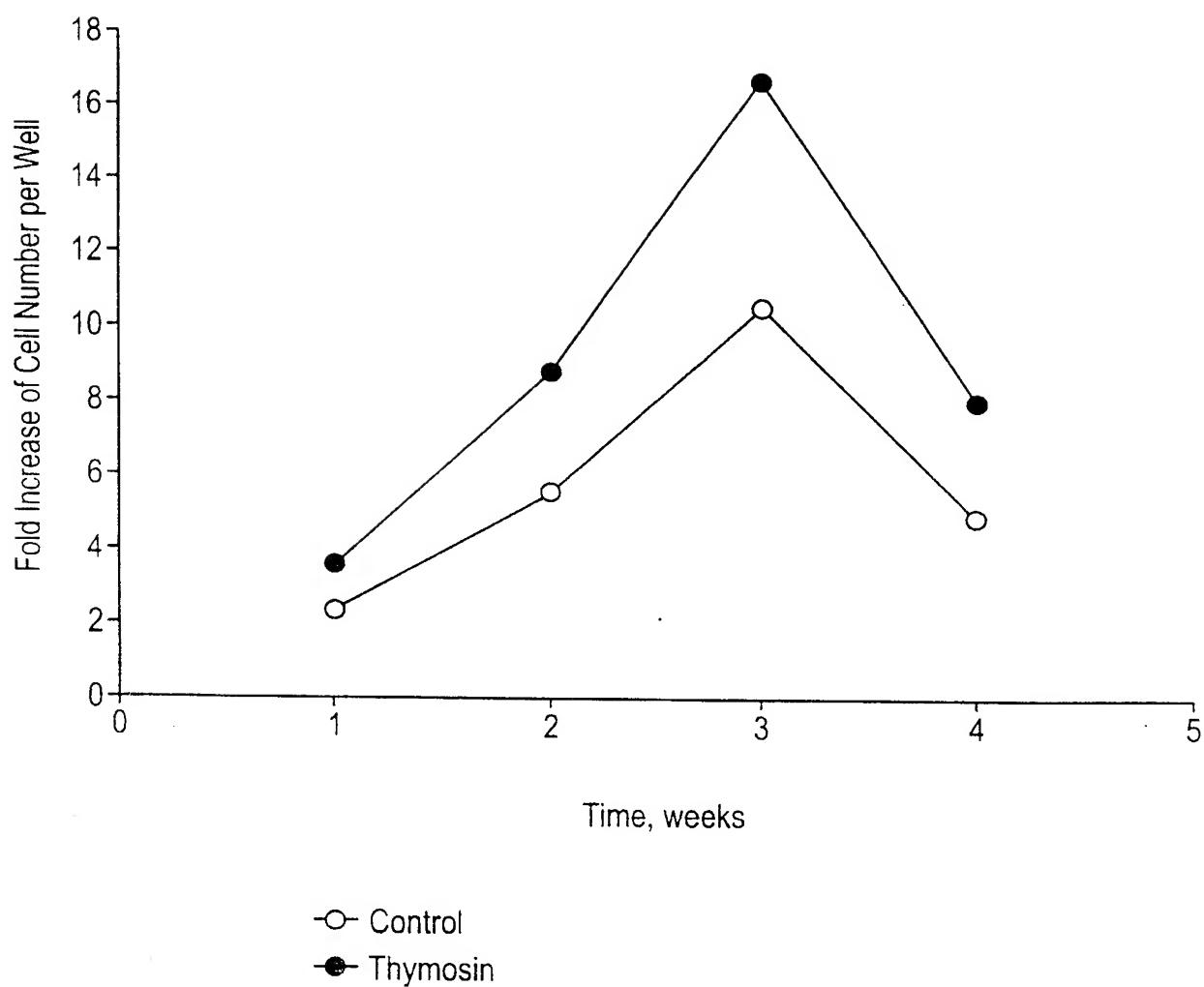
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FIG. 2



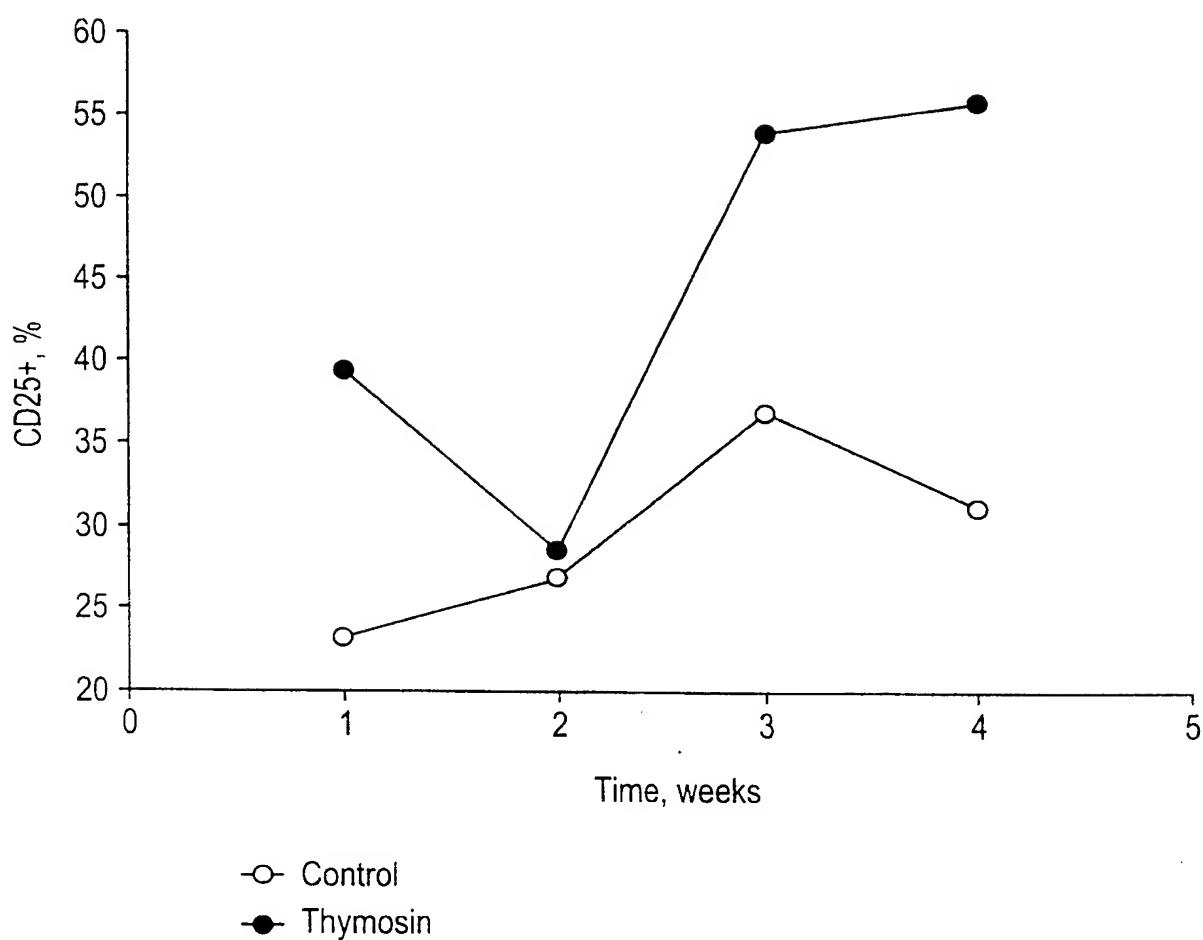
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FIG. 3



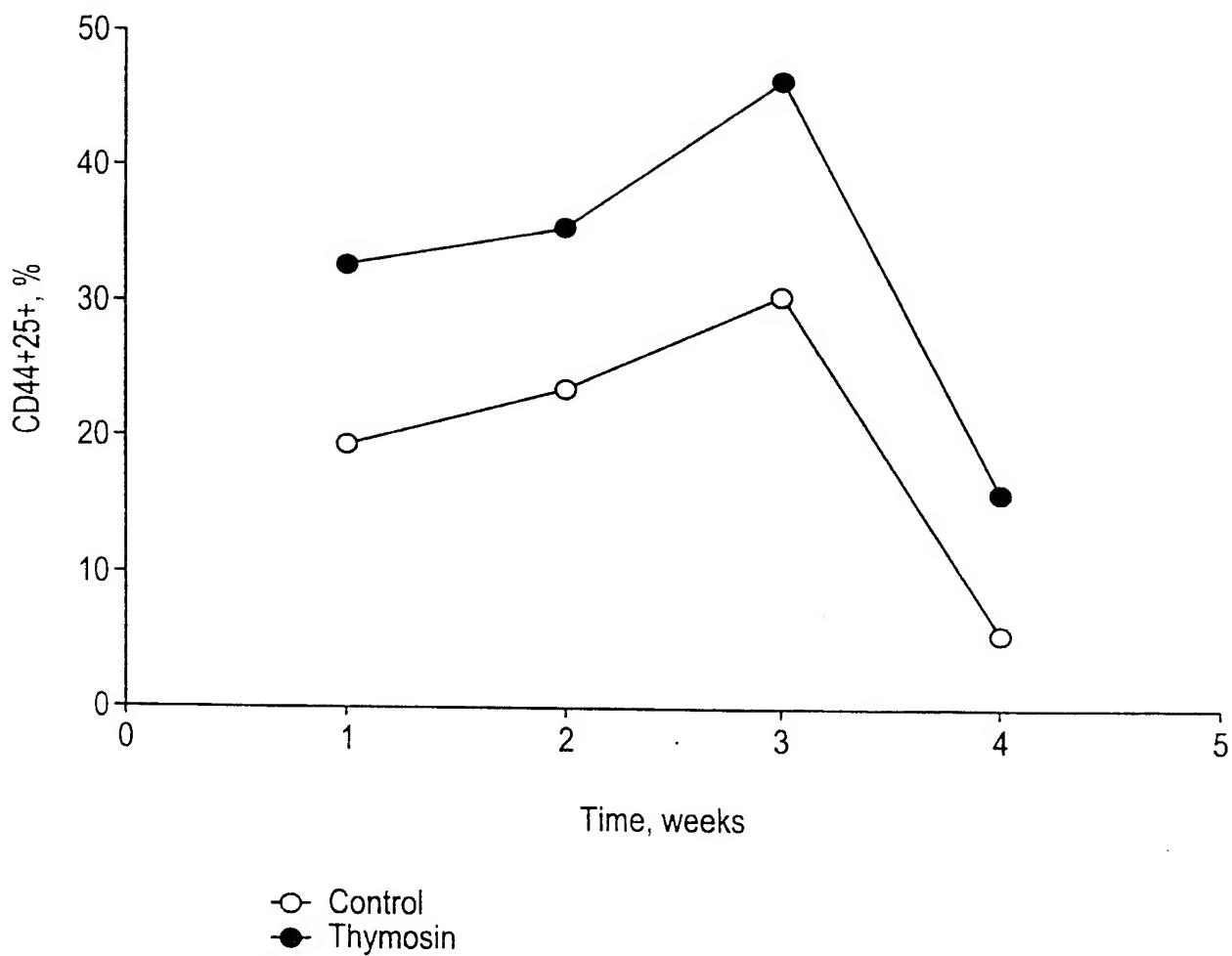
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FIG. 4



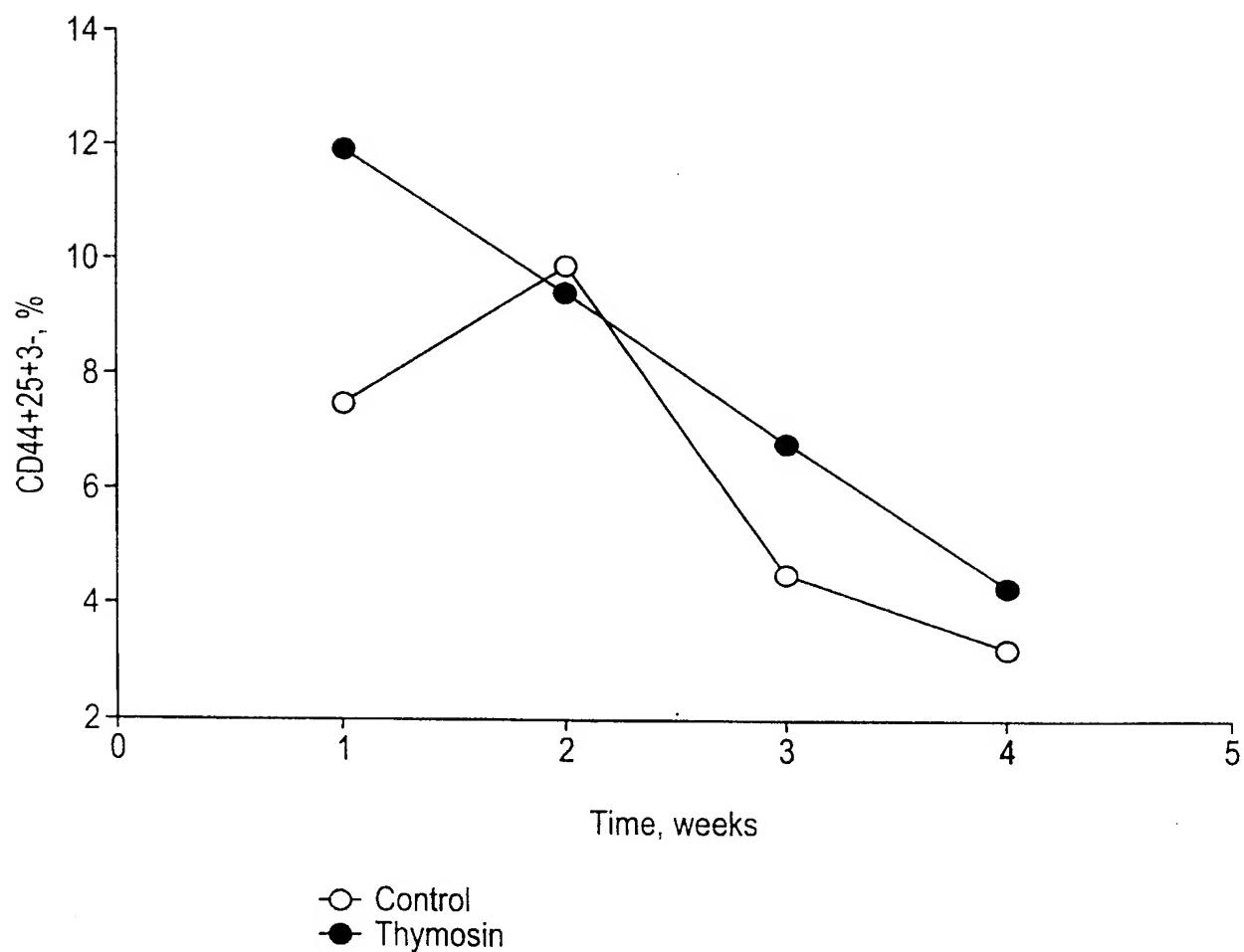
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FIG. 5



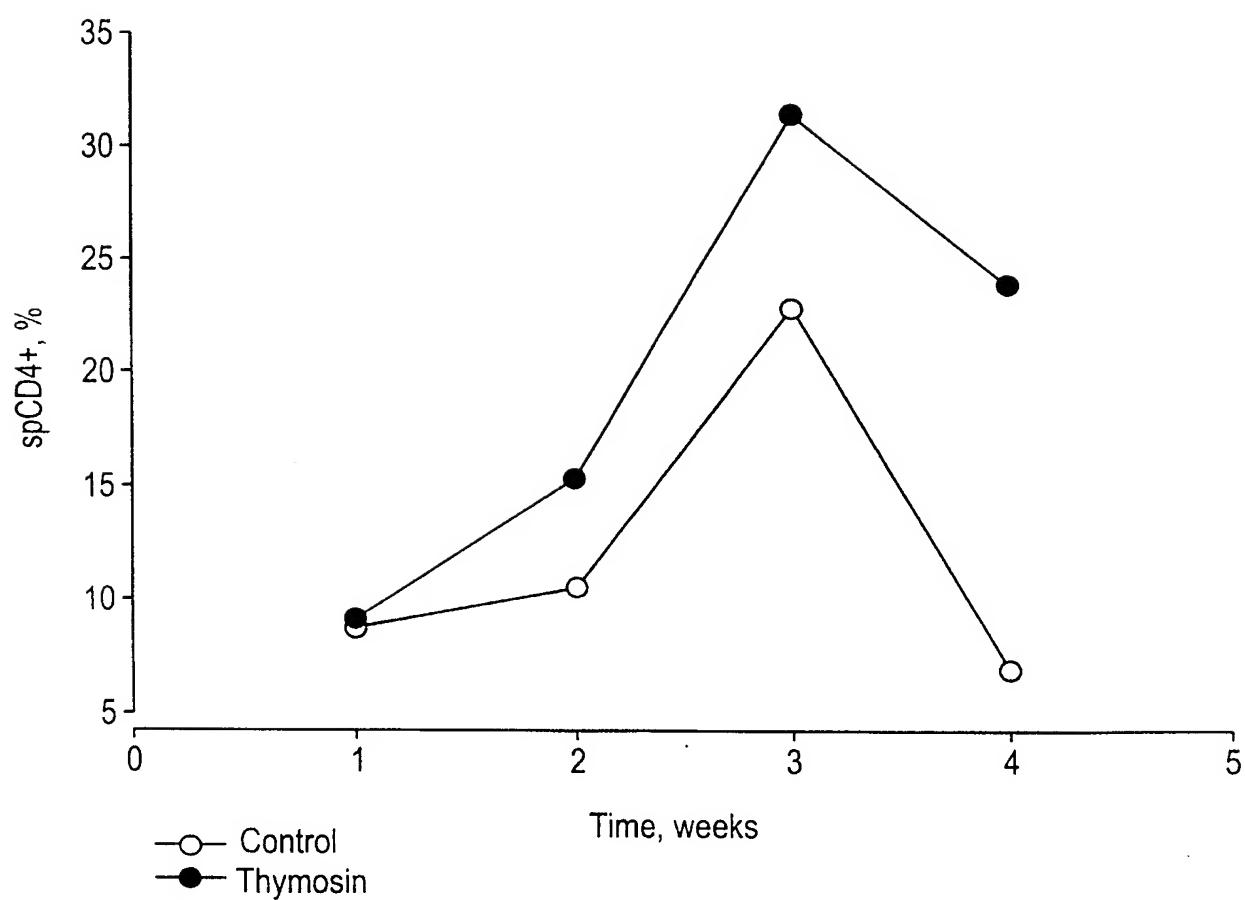
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FIG. 6



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FIG. 7



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/02830

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 A61K38/22

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YUMIKO OHTA ET AL.: "Immunomodulating activity of thymosin fraction 5 and thymosin alpha 1 in immunosuppressed mice" CANCER IMMUNOL. IMMUNOTHER., vol. 15, no. 2, 1983, pages 108-113, XP002063754 see abstract	1
Y	---	2-12
X	YUMIKO OHTA ET AL.: "Thymosin alpha 1 enhances haematopoietic colony formation by stimulating the production of interleukin 3 in nu/nu mice" INT.J. IMMUNOPHARMACOL., vol. 8, no. 7, 1986, pages 773-779, XP002063755 see abstract	1
Y	see page 777 - page 778 ---	2-12
		-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

**\* Special categories of cited documents :**

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\*&\* document member of the same patent family

Date of the actual completion of the international search

29 April 1998

Date of mailing of the international search report

22 05.98

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Tzschoppe, D

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/02830

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	CHEMICAL ABSTRACTS, vol. 92, no. 3, 21 January 1980 Columbus, Ohio, US; abstract no. 16153, KHAITOV ET AL.: "Factors controlling hematopoietic stem cell recirculation. IV. Effect of thymosin on the migration and differentiation of hematopoietic stem cells" XP002063757 see abstract & TSITOLOGIYA, vol. 21, no. 9, 1979, pages 1058-1064, ---	1-12
X	CHEMICAL ABSTRACTS, vol. 114, no. 25, 24 June 1991 Columbus, Ohio, US; abstract no. 241049, KONDO, KAORU: "Effects of thymic humoral factors on hematopoietic stem cells in human" XP002063758 see abstract	1
Y	& NAGOYA-SHIRITSU DAIGAKU IGAKKAI ZASSHI, vol. 41, no. 3, 1990, pages 467-482, ---	2-12
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International Application No

PCT/US 98/02830

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